



Air Pollution Technology Fact Sheet



1. Name of Technology: Fiber-Bed Scrubber

This type of technology is a part of the group of air pollution controls collectively referred to as “wet scrubbers.” Fiber-bed scrubbers are also known as wetted-filter scrubbers and mist eliminators.

2. Type of Technology: Removal of air pollutants by inertial and diffusional interception.

3. Applicable Pollutants:

Fiber-bed scrubbers are used to collect fine and/or soluble particulate matter (PM) or as mist eliminators to collect liquid aerosols, including inorganic (e.g., sulfuric acid mist) and volatile organic compounds (VOC). Insoluble and/or coarse PM will clog the fiber bed with time, and VOC which are difficult to condense will not be collected efficiently (EPA, 1998; Enviro-Chem, 1999).

4. Achievable Emission Limits/Reductions:

Fiber-bed scrubber collection efficiencies for PM and VOC mists generally range from 70 to greater than 99 percent, depending upon the size of the aerosols to be collected and the design of the scrubber and the fiber beds (Enviro-Chem, 1999).

5. Applicable Source Type: Point

6. Typical Industrial Applications:

Fiber-bed scrubbers are used to control aerosol emissions from chemical, plastics, asphalt, sulfuric acid, and surface coating industries. They are also used to control lubricant mist emission from rotating machinery and mists from storage tanks. Fiber-bed scrubbers are also applied downstream of other control devices to eliminate a visible plume. Despite their potential for high collection efficiency, fiber-bed scrubbers have had only limited commercial acceptance for dust collection because of their tendency to become plugged (Enviro-Chem, 1999; Perry, 1984)

7. Emission Stream Characteristics:

- a. Air Flow:** Fiber-bed scrubbers can treat flows from 0.5 to 47 standard cubic meters per

second (sm^3/sec) (1,000 to 100,000 standard cubic feet per minute (scfm)) (Hassan, 1999; Enviro-Chem, 1999).

- b. Temperature:** The temperature of the inlet waste gas flow is generally restricted by the choice of materials. Plastic fiber beds are generally restricted to operate below 60°C (140°F).
- c. Pollutant Loading:** Inlet flow loadings can range from 0.2 to 11 grams per standard cubic meter (g/sm^3) (0.1 to 5 grains per standard cubic foot (gr/scf)) (Hassan, 1999).

8. Emission Stream Pretreatment Requirements:

Waste gas streams are often cooled before entering fiber-bed scrubbers to condense as much of the liquid in the flow as possible and to increase the size of the existing aerosol particles through condensation. A prefilter is generally used to remove larger particles from the gas stream prior to its entering the scrubber (Enviro-Chem, 1999).

9. Cost Information:

The following are cost ranges (expressed in third quarter 1995 dollars) for orifice wet scrubbers of conventional design under typical operating conditions, adapted from EPA cost-estimating spreadsheets (EPA, 1996) and referenced to the volumetric flow rate of the waste stream treated. For purposes of calculating the example cost effectiveness, the pollutant is PM at a loading of approximately $7 \text{ g}/\text{sm}^3$ ($3 \text{ gr}/\text{scf}$) and waste gas flow ranging from 0.5 to $47 \text{ sm}^3/\text{sec}$ (1,000 to 100,000 scfm). The costs do not include costs for post-treatment or disposal of used solvent or waste (Hassan, 1999).

- a. Capital Cost:** \$2,100 to \$6,400 per sm^3/sec (\$1.00 to \$3.00 per scfm)
- b. O & M Cost:** \$3,500 to \$76,000 per sm^3/sec (\$1.60 to \$36 per scfm), annually
- c. Annualized Cost:** \$4,300 to \$77,000 per sm^3/sec (\$2.00 to \$37 per scfm), annually
- d. Cost Effectiveness:** \$40 to \$710 per metric ton (\$36 to \$644 per short ton), annualized cost per ton per year of pollutant controlled

10. Theory of Operation:

In fiber-bed scrubbers, moisture-laden waste gas passes through beds or mats of packing fibers, such as spun glass, fiberglass, or steel. If only mists are to be collected, small fibers may be used, but if solid particles are present, the use of fiber-bed scrubbers is limited by the tendency of the beds to plug. For PM collection, the fiber mats must be composed of coarse fibers and have a high void fraction, to minimize the tendency to plug. The fiber mats are often sprayed

with the scrubbing liquid so particles can be collected by deposition on droplets and fibers. For PM removal, the scrubber design may include several fiber mats and an impingement device. The final fiber mat is typically dry for the removal of any droplets which are still entrained in the gas stream (EPA, 1998; Perry, 1984).

11. Advantages/Pros:

Advantages of fiber-bed scrubbers include (Cooper, 1994; Enviro-Chem, 1999):

2. Can handle flammable and explosive dusts with little risk;
2. Can handle mists;
3. Relatively low pressure drop;
4. Provides cooling for hot gases; and
5. Corrosive gases and dusts can be neutralized.

12. Disadvantages/Cons:

Disadvantages of fiber-bed scrubbers include (Perry, 1984, Cooper, 1994):

1. Effluent liquid can create water pollution problems;
2. Waste product collected wet;
3. High potential for corrosion problems;
4. Protection against freezing required;
5. Collected PM may be contaminated, and may not be recyclable; and
6. Disposal of waste sludge may be very expensive.

13. Other Considerations:

For liquid aerosols, the used scrubbing liquid must be treated to remove the captured pollutant from the solution. The effluent from the column may be recycled into the system and used again. This is usually the case if the solvent is costly (e.g., hydrocarbon oils, caustic solutions). Initially, the recycle stream may go to a waste treatment system to remove the pollutants or the reaction product. Make-up scrubbing liquid may then be added before the liquid stream reenters the column (EPA, 1996).

For PM applications, wet scrubbers generate waste in the form of a slurry. This creates the need for both wastewater treatment and solid waste disposal. Initially, the slurry is treated to separate the solid waste from the water. The treated water can then be reused or discharged.

Once the water is removed, the remaining waste will be in the form of a solid or sludge. If the solid waste is inert and nontoxic, it can generally be landfilled. Hazardous wastes will have more stringent procedures for disposal. In some cases, the solid waste may have value and can be sold or recycled (EPA, 1998).

14. References:

Cooper, 1994. David Cooper and F. Alley, Air Pollution Control: A Design Approach, 2nd Edition, Waveland Press, Prospect Heights, IL, 1994.

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EPA, 1996. U.S. EPA, Office of Air Quality Planning and Standards, "OAQPS Control Cost Manual," Fifth Edition, EPA 453/B-96-001, Research Triangle Park, NC February.

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Hassan, 1999. Nadeem Hassan, Monsanto Enviro-Chem Systems, (314) 275-5782, personal communication with Eric Albright, May 26, 1999.

Perry, 1984. "Perry's Chemical Engineers' Handbook," edited by Robert Perry and Don Green, 6th Edition, McGraw-Hill, New York, NY, 1984.